UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
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ADVANCE REPORT
on the
SEDIMENTATION SURVEY OF LAKE DECATUR
DECATUR, ILLINOIS

April 8 - July 3, 1936

by

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In Cooperation With

Illinois Agricultural Experiment Station
Urbana, Illinois
H. W. Mumford, Director

and

Illinois Department of Registration
Water Survey Division
Urbana, Illinois
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Sedimentation Studies
Division of Research
SCS-SS-12
April, 1937

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GENERAL INFORMATION

Location: State: Illinois (fig. 1).

County: Macon, Tps. 16 and 17 N., Rs. 2 and 3 E.

Distance and direction from nearest city: The lake borders the City of Decatur on the south and east, and extends about 8 miles upstream from the northeast city limits.

Drainage and backwater: Sangamon River and its tributaries, Sand Creek and Big Creek.

Ownership: The City of Decatur.

Purpose served: Municipal water supply.

Description of dam: The dam, which has a total length of 1,900 feet, extends nearly north and south across the Sangamon River Valley. It consists of three segments, (1) the concrete spillway in the middle, (2) the combined highway fill and earthen segment on the south, and (3) the earthen segment north of the spillway. The upstream faces of the end segments have slopes of 2.5 : 1, and are faced with concrete slab. The upstream face of the spillway is vertical. Both end segments meet the spillway at oblique angles, giving the dam a zig-zag pattern. The principal dimensions of the structure are as follows:

Table 1.-Dimensions of Decatur Dam, Decatur, Ill.

	Middle segment (Concrete spillway)	South Segment (Earthen)	North Segment (Earthen)
	(Feet)	(Feet)	(Feet)
Length..............	480	675	675
Height above valley bottom............	25	47	47
Crest thickness.....	4	30	10
Base thickness......	14	45	30
Crest elevation (U.S.G.S. datum)...	610	632	632

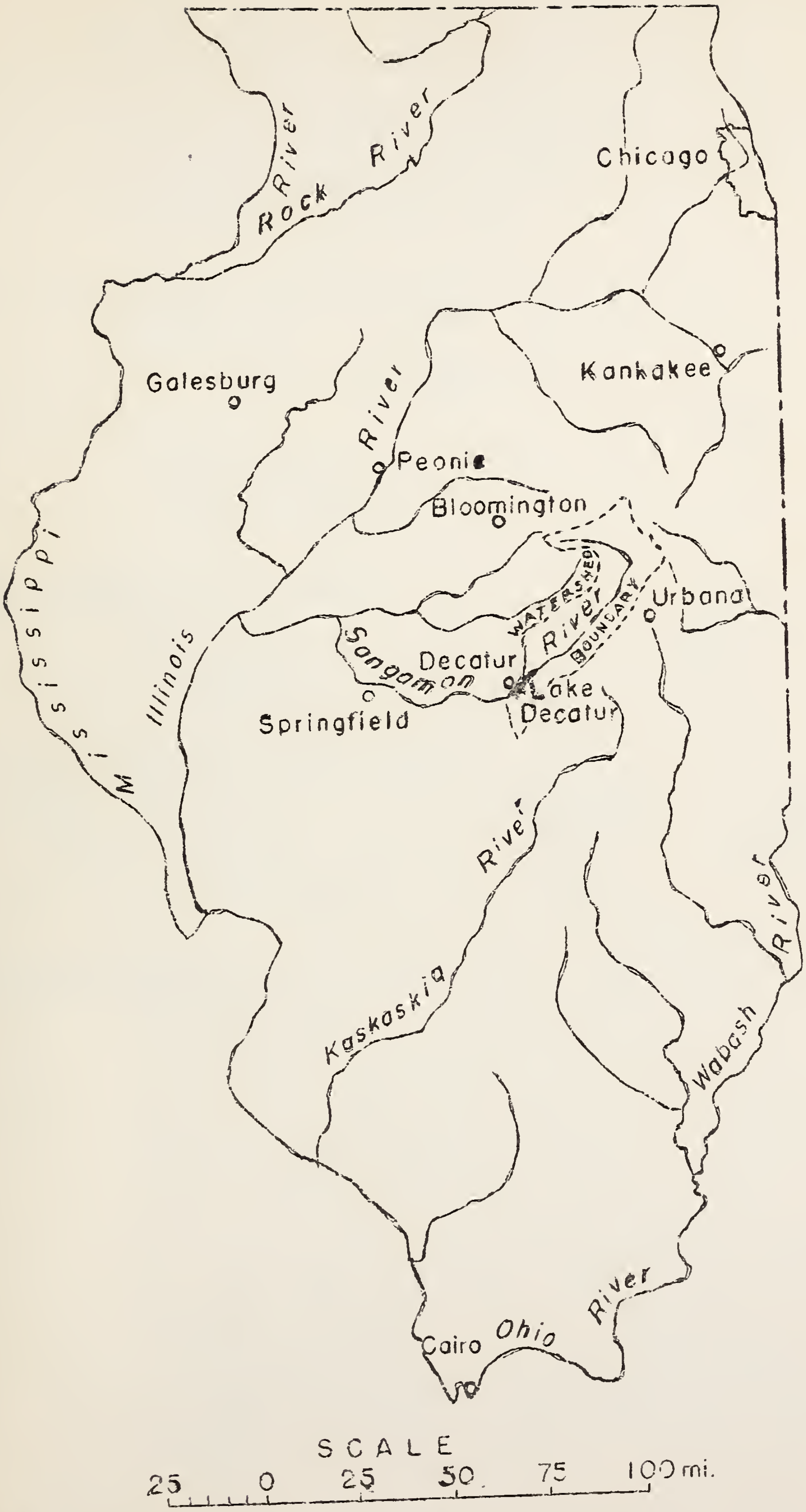


Fig. 1- Location and general relations of Lake Decatur and its watershed.

Provision has been made for 2.5-foot flashboards along the entire length of the spillway but they are never used. Two floodgates 9 feet high and 14 feet wide, with the tops at crest level, adjoin the north end of the spillway. In addition, a 3-by 4-foot flushing conduit in the middle of the spillway provides an outlet at a depth of 15 feet below spillway crest.

Date of completion: April 16, 1922.
Average date of survey: May 1936. Age: 14.2 years.

Length of lake (original and present):

	Miles
Lake proper	10.4
Ponded channel	4.1
Total backwater	14.5

Area of lake at crest stage:

	Acres
Original	2,805
Present	2,747
Reduction	58

Storage capacity at crest stage:

	Acre feet	Gallons
Original	19,738	6,431,627,300
Present	16,930	5,516,640,500
Reduction	2,808	914,986,800

Historical note: Prior to 1922, the municipal water supply of Decatur was pumped from a very small segment of ponded channel in which water was retained by a dam 8 feet high located one-eighth mile below the present dam. With the rapid industrial growth of Decatur the water supply from this uncertain source became precarious during dry seasons. In 1922, the Decatur Water Supply Company, an Illinois corporation, constructed the reservoir and for a period of 10 years furnished water to the city under contract. During this period the extensive program of shore-line stabilization by riprapping was carried out. In 1932 the control and administration of the lake was acquired by the City of Decatur. Cost figures on the Lake Decatur development, supplied by city officials, follow:

Dam	$940,000.00
Land	547,897.13
Clearing of land	119,295.02
Roads and bridges	309,091.97
Riprapping	97,555.81
Total original cost	$2,013,839.93

General character of reservoir basin: Lake Decatur occupies a relatively long, somewhat sinuous stretch of the Sangamon River valley through which the stream formerly followed a tortuous, meandering course over a well-developed flood plain. The flood plain is slightly less than 0.5 mile in width on the average, and is bordered by precipitous bluffs and steep slopes. The width of the lake basin ranges from one-fourth to three-fourths of a mile. On range 017-018, near the dam, the maximum measured depth to the original flood plain is 16 feet, and the extreme depth in the original channel is about 28 feet. The average gradient of the flood plain through the reservoir basin is about 1.5 feet per mile. At least half of the lake area has an average depth of less than 10 feet. In brief, therefore, the lake may be described as long, narrow, and shallow.

Throughout the lake proper the impounded water covers the entire flood plain and encroaches slightly upon the adjacent bluffs and slopes. Thus most of the lake shore is steep or even precipitous.

The submerged channel ranges in width from 100 to 200 feet and in depth from 5 to 10 feet below the general level of the flood plain. Its meandering course through the lake is plotted on the accompanying reservoir map (fig. 2 in back).

The only important tributary arms are Big Creek and Sand Creek, which join the main lake about 2 miles above the dam.

Former silt surveys: During the period September 1931 to January 1932 the Illinois Water Survey Division, in cooperation with the Decatur Water Supply Co., made a study of sedimentation in Lake Decatur. W. F. Churchill, engineer of the Illinois Water Survey Division, and F. S. Washburn, Macon County engineer, cooperated in carrying out most of the

field work. Fifty-five ranges were established across the lake for measurement of water depth and silt thickness. All end points were located accurately with respect to known landmarks by means of transit traverses, and their elevations were established by lines of levels from convenient benchmarks. Conspicuous permanent monuments were installed to mark many of the range ends, and several of these were used to advantage in the 1936 survey.

For the 1931-32 survey the ranges were so distributed as to permit a study of the effects on sedimentation of several of the bridges and fills which extend across the lake and permit water to flow only through relatively narrow openings. The following locations were selected for special study (see fig. 2, in back).

1. County highway bridge across Sand Creek arm (segment 6).
2. State Highway 10 bridge (segment 25).
3. Old Wabash Railroad bridge (segment 27).
4. New Wabash Railroad bridge (segment 28).
5. Illinois Terminal Co. bridge (segment 29).
6. Rae's bridge (segment 35).

In the greater part of the lake ranges were established at intervals of 0.75 to 1.5 miles. In the vicinity of the three bridges in segments 27, 28, and 29, however, 20 ranges were established within a linear distance of 0.5 mile. Near Rae's bridge 15 ranges were established within a distance of a third of a mile.

Three distinctive devices were utilized in measuring silt and water on the several ranges. In locating the boat for soundings a light steel cable was fastened on shore at both ends of a range and stretched tightly enough to keep the boat on the range as it crossed the lake. Wooden floats attached to the cable at 5-foot intervals served as convenient measures for spacing soundings as the boat was pulled along the cable by hand. When not in use the line with floats attached was wound and stored on a reel of the type used for garden hose.

Water depth measurements were made by means of a very light sounding lead, weighing only one pound,

which was suspended on a wire. The sounding lead consisted of the bottom section of an ordinary tin-plated can, 1 inch high and 5 inches in diameter, with openings in the rim to permit rapid filling with water, and weighted with a thin lead disk. This apparatus was designed to give maximum sensitivity to the top surface of very soft, uncompacted silt deposits.

Silt depths were determined with a special silt sampler, consisting of a 3-foot length of thin iron tubing, 4 inches in diameter, and closed at the upper end. This was lowered to the lake bottom by attaching successive sections of threaded iron pipe. Samples were obtained by forcing the tube solidly into the bottom sediment. If the silt was penetrated and the subsilt material was sufficiently coherent to seal the bottom of the tube, a complete section or core of the sediment was obtained. A number of slots one-half inch wide and 5 inches long in the walls of the tube permitted inspection of the sample at any level.

In 1931 soundings were taken on all the original ranges, but silt measurements were made only in the upper part of the lake above segment 25 and near the heads of the Sand Creek and Big Creek arms. No silt measurements were obtained in the old channel because the depths of sediment there exceeded the length of the iron tube sampler. Cross sections of all ranges were plotted on a horizontal scale of 1 inch to 100 feet and a vertical scale of 1 inch to 4 feet.

Area of watershed: 906 square miles.

General character of watershed:

Geology.- Considering its large area, the Lake Decatur drainage basin exhibits comparative lithologic uniformity. It lies entirely within the area covered by Shelbyville till, a glacial formation which resulted from the advance of the southwestern salient of the Michigan glacial lobe in Early Wisconsin time. Nearly everywhere the till is covered by the widespread wind-deposited loess, which in the Lake Decatur watershed attains thicknesses of as much as 4 feet. Beneath the Wisconsin drift are deposits of two earlier glacial periods. The following table gives the approximate average thickness and stratigraphic position of each of the drift and

bedrock formations in the vicinity of Lake Decatur (2, 3).[1/]

Table 2.- Stratigraphy of the Lake Decatur watershed.

Age: Glacial	Age: Interglacial	Lithology	Thickness
			(Feet)
Wisconsin.	. . . .	(Loess.	2
		(Till.	70
	Peorian. . . .	)	
Iowan.	. . . .	) Loess.	2
	Sangamon. . .	Soil and gumbotil	3
Illinoian.	. . . .	Till.	30
	Yarmouth. . .	Soil.	2
Pre-Illinoian (Kansan or Nebraskan, (5, p.46)		Till.	30
Pennsylvanian"coal measures"		Shale, sandstone, and coal.	630 plus

The Shelbyville (Wisconsin) till and its thin loess mantle, which form an almost continuous cover over the underlying formations in the watershed, are the principal sources of Lake Decatur sediment. The Iowan-Peorian loess zone and the Sangamon gumbotil were observed in several outcrops around the lake, and the still older Illinoian till is exposed in steep banks near the State Highway 10 bridge and near the Decatur Country Club, about half a mile downstream on the left bank. No outcrops of the pre-Illinoian till are known in the watershed, and the Pennsylvanian bedrock is almost completely covered by the drift formations. Some fluvio-glacial sands and gravels in the form of valley-train and terrace deposits occur along the Sangamon River valley, notably at points on the west bank one-half mile above U. S. Highway 36 bridge (segment 22) and on the east bank at Rae's bridge (segment 35).

Topography and drainage.- The watershed of Lake Decatur lies on the broad, gently undulatory Shelbyville ground moraine. The southern and western margins of this plain are marked by a conspicuous ridge which represents a terminal moraine formed at the edge of the Early Wisconsin glacier. This ridge, known as the Shelbyville moraine, extends from Peoria generally southeastward through Clinton, Blue Mound

1/ Numbers in parentheses refer to Literature Cited, p. 23.

(southwest of Decatur), and Shelbyville. The headwaters of the Sangamon River rise upon the southern slopes of a similar ridge, the Bloomington moraine, between Bloomington and Gibson City (4, pp. 190-200). These moraines, composed of boulder clay, sandy, and gravel and covered with a thin blanket of loess, stand about 100 feet above the surrounding plains and are the most conspicuous features of the region. Only an insignificant amount of geological erosion has occurred since the retreat of the Early Wisconsin ice sheet, but many swampy areas have been drained artificially to permit cultivation of the fertile dark soil. The region is in topographic youth and the only normal erosional features of the plain are the major valleys, such as those of the Sangamon River and its larger tributaries.

From its point of origin near the small town of Ellsworth, east of Bloomington, the Sangamon River flows southeastward about 25 miles airline, and then makes a nearly right-angle bend to flow southwestward about 50 miles to the vicinity of Decatur. The gradient is low and the stream course meanders. At Decatur the valley has reached a mature stage of development. It has an average width of nearly one-half mile, and the valley flat lies 50 to 90 feet below the level of the upland. The valley walls are steep or even precipitous, rising to the upland level within a horizontal distance of one-fourth to one-eighth mile.

Soils.- On the soils survey maps of the various counties of the watershed the soils are divided into four principal groups, each of which is further divided into specific types (6, 7). Table 3 gives the chief characteristics of each soil type and its relative extent in Macon County, which includes about one-fourth of the Lake Decatur watershed and is probably typical of the total area.

Table 3.- Character and extent of soils in Macon County, Ill.

Soil Classification	Relative Extent (Percent)	Chief Characteristics
Upland Prairie Soils		
Brown silt loam......	64.71	Dark colored and usually
Black clay loam......	18.54	rich in organic matter,
Brown-gray silt loam on tight clay.......	.61	derived chiefly from wild prairie grasses.
Brown sandy loam.....	.07	
	83.93	
Upland Timber Soils		
Yellow-gray silt loam	7.79	Light colored zones near
Yellow silt loam.....	3.45	stream valleys which support
Yellow-gray sandy loam.................	.09	forests of long standing.
Yellow sandy loam....	.02	
	11.35	
Terrace Soils		
Brown silt loam over sand or gravel......	.18	Terrace and valley-train deposits of fluvial and
Yellow-gray silt loam over sand or gravel..	.11	fluvio-glacial origin.
Brown silt loam over sand or gravel......	.01	
	.30	
Late Swamp and Bottom-land Soils		
Deep peat............	.01	Peats, silts, and sands
Deep brown silt loam.	.98	of flood plains
Mixed loam...........	2.46	
	3.45	
Lake Decatur..........	.97	
	100.00	

The upland soils range in thickness roughly from 20 to 40 inches, and are regarded as relatively immature. These soils are typical of the famous Midwestern Corn Belt, characterized by dark fertile soils derived from Pleistocene glacial formations. The bottomland soils, in areas subject to periodical deposition by overwash of floodwaters, have variable agricultural value.

Erosion conditions.- On the upland areas of the watershed, which comprise about 90 percent of the total drainage area, the extent of accelerated soil erosion, largely of the sheet erosion type, ranges from slight in the flatter areas to moderate in the more strongly rolling belts of the recessional moraines.

The bottomlands, comprising about 3 percent of the total drainage area, are not subject to appreciable erosion but rather to deposition during overbank floods.

The slopes adjacent to the main valley and its larger tributaries, comprising about 7 percent of the watershed, are subject to the most severe erosion occurring in the drainage area. In a belt nearly 1 mile wide along each side of the Sangamon River valley, overgrazing and cultivation of clean-tilled crops have greatly accelerated the normal erosion in many places (fig. 3A). Severe sheet erosion has removed all the top soil on numerous slopes, and some extensive systems of gullies have developed.

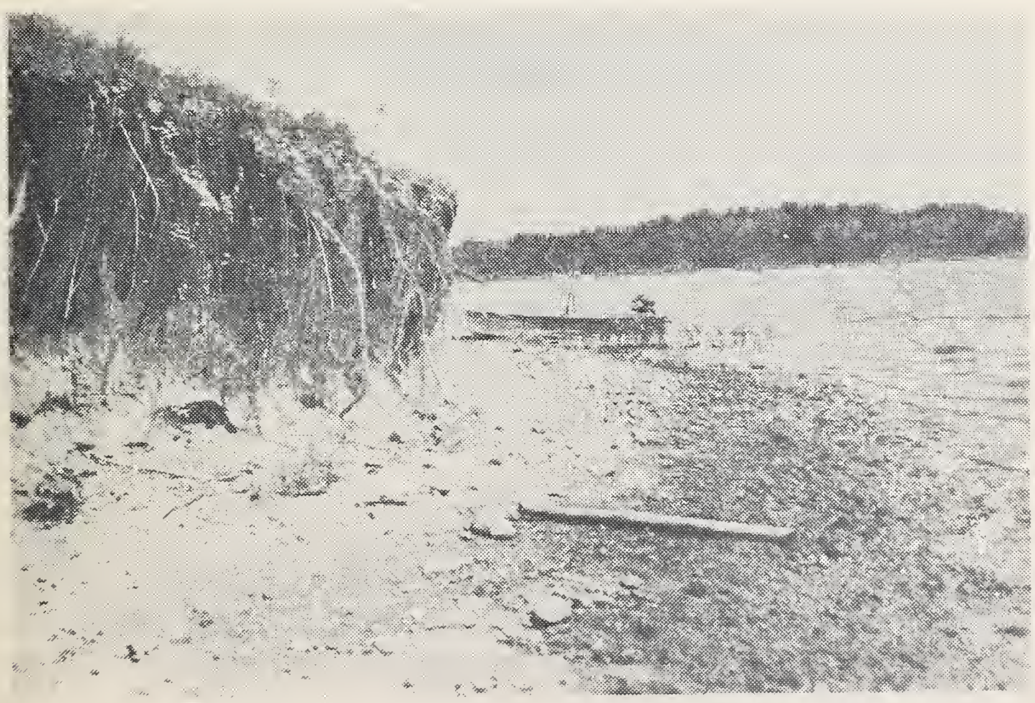
Land use.- The Lake Decatur watershed lies in a rich and productive agricultural region. Virtually no idle land can be found, and the farms are among the finest in the country. No exact figures pertaining to land use for the current year are available; hence the following approximate figures have been compiled from soils reports of the Illinois Agricultural Experiment Station and from records of the U. S. Department of Agriculture.

	Percent
Forest	3
Pasture	15
Crops	82
	100

Approximate percentages of land devoted to the various crops are as follows:

	Percent
Corn	70
Oats	10
Soybeans	10
Wheat	5
Alfalfa and other hay crops	5
	100

A. Eroded area at head of a gully tributary to Lake Decatur, which is typical of the mile-wide belts along each side of the Sangamon River Valley. Note the severe gullying in the field in the background, and the tree roots in the foreground exposed by erosion.



B. Wave-cut bank and gravel beach on north shore of the Big Creek arm.

Mean annual rainfall: 36.68 inches, according to records of the Illinois Water Survey Division.

Inflow: The nearest gaging station on the Sangamon River is at Monticello, 28 miles above Decatur. By increasing U. S. Geological Survey discharge measurements at this station by 65 percent, in proportion to the relative drainage areas above the dam and above the station, it was estimated that the average inflow into Lake Decatur from the time of construction in 1922 to September 1934 was about 500,000 acre-feet per year. In the same manner it was estimated that a maximum inflow of about 1,300,000 acre-feet occurred in the hydrologic year 1926-27, and that a minimum inflow of about 80,000 acre-feet occurred in 1933-34.

Draft on reservoir:
Municipal water plant:

Maximum.......7,500,000 gallons per day (summer)
Minimum.......6,000,000 gallons per day (winter)

The condenser system for the steam plant of the A. E. Staley Manufacturing Co. pumps approximately the same amount as is used by the city. All of this water is returned to the lake, however, without having been treated or contaminated in any way.

HISTORY OF SURVEY

The survey of Lake Decatur was made during the period April 8 to July 3, 1936, by the Central Reservoir Party, Section of Sedimentation Studies, Division of Research. The personnel of the party consisted of Louis M. Glymph, Jr., party chief; Victor H. Jones, assistant chief; William G. Shannon; Harry L. Fischer; and Oscar D. Price. General arrangements for the survey, including a reconnaissance of the lake and portions of the drainage area, were made by D. Hoye Eargle.

Under the terms of a cooperative project agreement with the Illinois Agricultural Experiment Station and the Illinois Department of Registration, Water Survey Division, the field party assisted in the collection of silt samples as outlined below for chemical analysis of plant food elements. Dr. E. E. DeTurk, chief, Division of Soil Analysis, and F. H. Crane, assistant chief, Division of Soil Fertility, of the Illinois Agricultural Experiment Station, supervised the collection of samples. Dr. DeTurk is in charge of analyses now under way in the laboratories of the Experiment Station at Urbana.

Under this agreement, also, the field party assisted in collection of 15 water samples on both May 4 and 6 by Dr. Max Suter of the Illinois Water Survey Division for investigation of turbidity and rate of movement of flood flows through the reservoir.

Field work began with chaining of a 2,000-foot base line across the lake along the south side of the Baltimore and Ohio Railway fill (segment 22, fig. 2A). From this line 73 triangulation stations were established by plane table and alidade. An auxiliary base line, also 2,000 feet in length, was chained across the lake along the north shoulder of State Highway 10, between triangulation stations 1,038 and 1,039. These end points were marked in the field with lengths of numbered iron pipe set in concrete. It was necessary to offset these monuments 3 feet north at right angles to the base line.

As triangulation progressed, a second group of men began mapping the crest-level shore line. In the delta areas of the main lake and tributary arms both the original and present crest lines were mapped. The total length of shore line surveyed was approximately 70 miles. All mapping was done with plane table and alidade on a scale of 500 feet to the inch.

Original and present reservoir capacities and silt volumes were determined by the range method of survey (1, pp. 128-137). For this purpose 49 ranges were established, sounded, and spudded. Twenty-four of these ranges had been previously established and sounded by the Illinois Water Survey Division in 1931-32. These previously established ranges were used wherever possible, but it was found that not all of them were necessary to give a reliable figure on volume of accumulated sediment, particularly in the vicinity of Rae's bridge (segment 35) and the old and new Wabash Railroad bridges (segments 27 and 28), where ranges had been very closely spaced in 1931-32. No unusual concentration of sediment was found near the bridge fills.

On several ranges, where it was either impossible or impractical to establish regular cut-in stations for range intersection, distances between soundings and spuddings were measured by means of the special cable used in the earlier survey by the Water Survey Division (see under "Former silt survey").

An added feature of the present survey was the establishment of 14 special shore-line ranges to study the importance of wave erosion as a factor in reservoir silting. In addition to these special ranges, 13 end sections of regular ranges were measured in detail to establish the shore

profile. Detailed cross sections were made by levels from the initial point down to the water's edge and by closely spaced soundings out into the lake to the limit of coarse wave-erosion debris. All points on these ranges were located by stadia. The wave-erosion ranges were given regular range numbers, beginning with 097 and running through 0109.

During preliminary conferences between field representatives of the Soil Conservation Service and the Illinois Water Survey Division, a question arose as to the comparative accuracy of the two types of sounding weights used by the respective organizations. The particular point in question was the extent to which the 8-pound sounding lead previously used by the Soil Conservation Service would sink into the exceedingly soft top sediment in Lake Decatur, thus increasing water-depth readings. The writers, together with Dr. Max Suter, Illinois Water Survey Division, and D. H. Eargle, assistant geologist, Soil Conservation Service, made a series of soundings for comparison of the two weights. The results of these tests showed the Illinois Water Survey Division apparatus to be slower in sinking through the water, but more sensitive to the top of the sediment. Numerical differences in water depths ranged from 0.05 to 0.15 foot, depending largely upon the ability of the individual to detect the contact of the heavier weight with the top of the sediment.

As a result of these tests the Soil Conservation Service field party developed a sounding weight combining as far as possible the sensitivity of the lighter weight with the speed of the heavier one. This apparatus consists of a bell-shaped aluminum casting with a base diameter of 5 inches, a top diameter of 2 inches, a height of approximately 6¼ inches, and a weight of about 5 pounds. This lead was subsequently used in all reservoir surveys in Illinois in 1936.

A study of bottom silts with respect to plant food constituents, texture, and colloidal content is now under way (January 1, 1937) at the Illinois Agricultural Experiment Station under the terms of a cooperative project agreement with the Soil Conservation Service. Dr. E. E. DeTurk, chief, Division of Soil Analysis, and F. H. Crane, assistant chief, Division of Soil Fertility, cooperated with the field party in obtaining the samples and Dr. DeTurk is directing the analytical investigations in the laboratories of the Experiment Station.

Pint jars of bottom sediment were obtained from 39 selected sites by means of two types of silt samplers.

For the thinner deposits on the submerged flood plain the iron tube sampler of the Illinois Water Survey Division was used, but samples from the channel where the sediment was more than 3 feet deep were obtained with the regular spud of the Soil Conservation Service. After the spud had penetrated the sediment it was carefully pulled to the surface and a complete section of the silt removed from the cups. In all cases the boat was anchored so that the spud could be thrown into the same spot repeatedly if a pint sample was not obtained in the first attempt. All jars of silt were sealed and labeled in the field for future analysis. It is expected that detailed results of these studies will be available in the near future for incorporation in a final report of this investigation.

A preliminary investigation of turbidity and suspended solids in the reservoir water was made by the Illinois Water Survey Division following a series of heavy rains early in May 1936. Dr. Max Suter, engineer of that Division, in cooperation with the writers, obtained a series of 15 water samples on May 4 and a similar series at the same localities on May 6. All samples were taken at depths 2 feet above the lake bottom with the Miller silt sampler, a device which permits pint milk bottles to be lowered empty to the required depth and then filled by tripping a catch which seals the top of the bottle. The samples were taken at intervals averaging slightly less than one mile from near the dam through the length of the lake to Coulter's Mill bridge (range 073-074). Quantitative analyses were made in the Illinois Water Survey Division laboratories by Dr. Suter.

ACKNOWLEDGMENTS

The Soil Conservation Service acknowledges the help and cooperation of many local officials and residents during the survey of Lake Decatur. Charles Lee, mayor of Decatur, and Henry H. Bolz, secretary of the Decatur Association of Commerce, aided materially in the general arrangements. John Rehfelt, superintendent of the municipal water department, L. A. Nalefski, water chemist, and E. J. McDonald, city engineer, furnished office facilities and information on the operation of the city water system. Sam A. Parr, superintendent of the lake, furnished boats, equipment, and information on the reservoir. Earl Cooper, formerly superintendent of the Lake Decatur Water Supply Co., furnished data on the construction, early operation, and history of the lake. The A. E. Staley Co. of Decatur provided tracing and drafting tables for preparation of field maps.

Under terms of a cooperative project agreement Dr. A. M. Buswell, director, and W. D. Gerber and Dr. Max Suter, engineers, of the Illinois Water Survey Division, supplied information on benchmarks and blueprints of the survey of 1931-32 and meteorological information on the watershed. The records of the Illinois Water Survey Division were available at all times. Members of the staff of the Illinois Agricultural Experiment Station furnished information on the watershed with particular reference to soil characteristics. The Illinois Geological Survey Division at Urbana furnished geological bulletins and maps covering parts of the drainage area.

SEDIMENT DEPOSITS

Character of sediment:

The sediment in Lake Decatur consists chiefly of uncompacted silt and clay ranging in color from gray or blue-gray in submerged areas to brown or rust where recently exposed to the air. Coarse sand, grit, and gravel occur along several sections of lake shore at the foot of wave-cut bluffs. No typical delta deposits have formed at the head of the main reservoir, but small deltas in the two major tributaries, Sand Creek and Big Creek, have filled the original stream channels for distances of 250 and 500 feet, respectively.

In the channel above the head of the open lake (range 067-068, see fig. 2B) the sediment differs little from that normally present in unregimented streams of this region. The bulk of the channel sediment is fine sand and silt with occasional gravel bars, all of which is subject to seasonal scour and fill.

Analyses of bottom sediment.- Analyses of 39 samples of bottom sediment from the localities given in table 4 are now being made by the Illinois Agricultural Experiment Station and the results will be incorporated in the final report on this investigation.

Table 4.- Silt sample localities, Lake Decatur, Ill.

Range	Location	Number of samples
Main lake:	Miles above dam	
017-018	0.1	3
05-06	1.8	3
01-02	2.8	3
013-014	3.4	2
032-033	4.8	3
034-035	5.4	2
038-039	5.8	3
049-050	7.3	3
055-056	7.8	3
057-058	8.7	3
073-074	11.4	1
Big Creek arm:	Miles above mouth	
023-024	0.3	3
027-028	0.9	4
Sand Creek arm:		
095-096	0.1	3

Distribution of sediment:

The average thickness of sediment in the main body of the lake increases more or less gradually from less than 1 foot near the dam to nearly 2 feet in the upper part of the reservoir. There is a notable absence of excessively thick delta deposits near the head of the lake, largely because of the uniformly fine texture of the incoming sediment, which is carried in suspension to all parts of the reservoir.

Throughout the reservoir the deepest accumulations of sediment occur in the submerged channel. The depths given in the following table are representative of the channel deposits in most of the main lake basin. On range 065-066, however, at the head of the open lake, two meander channels had been silted to a depth of about 4 feet, but the main channel was practically free of sediment at the time of survey, a season of subsiding flood waters. Flatter areas near crest on the same range had zero to 1.5 feet of sediment.

Table 5.- Depths of channel sediment in Lake Decatur.

Range	Distance above dam	Maximum depth of channel sediment
	(Miles)	(Feet)
03-04	2.2	4.1
013-014	3.4	3.2
034-035	5.4	2.7
053-054	7.6	6.7
075-076	8.3	4.6

Between ranges 059-060 and 067-068 has occurred the greater part of the above-crest deposition. This "delta area" has a length of about 1 mile and an average width of 1,500 feet. It is not a typical delta with a broad uninterrupted area of silt land, nor does it represent a large concentration of sediment in contrast to thinner deposits in the lower lake. It is simply a zone at the head of the lake in which deposition at and near crest level has resulted in the partial filling of shallow bays, oxbows, and auxiliary channels on the valley flat, and in the addition of new land to original banks and higher areas. This reach of valley during flood seasons carries water from bluff to bluff, but during normal periods of crest level flow it is a maze of swamps and channels, partly choked with willows, cattails, and grasses.

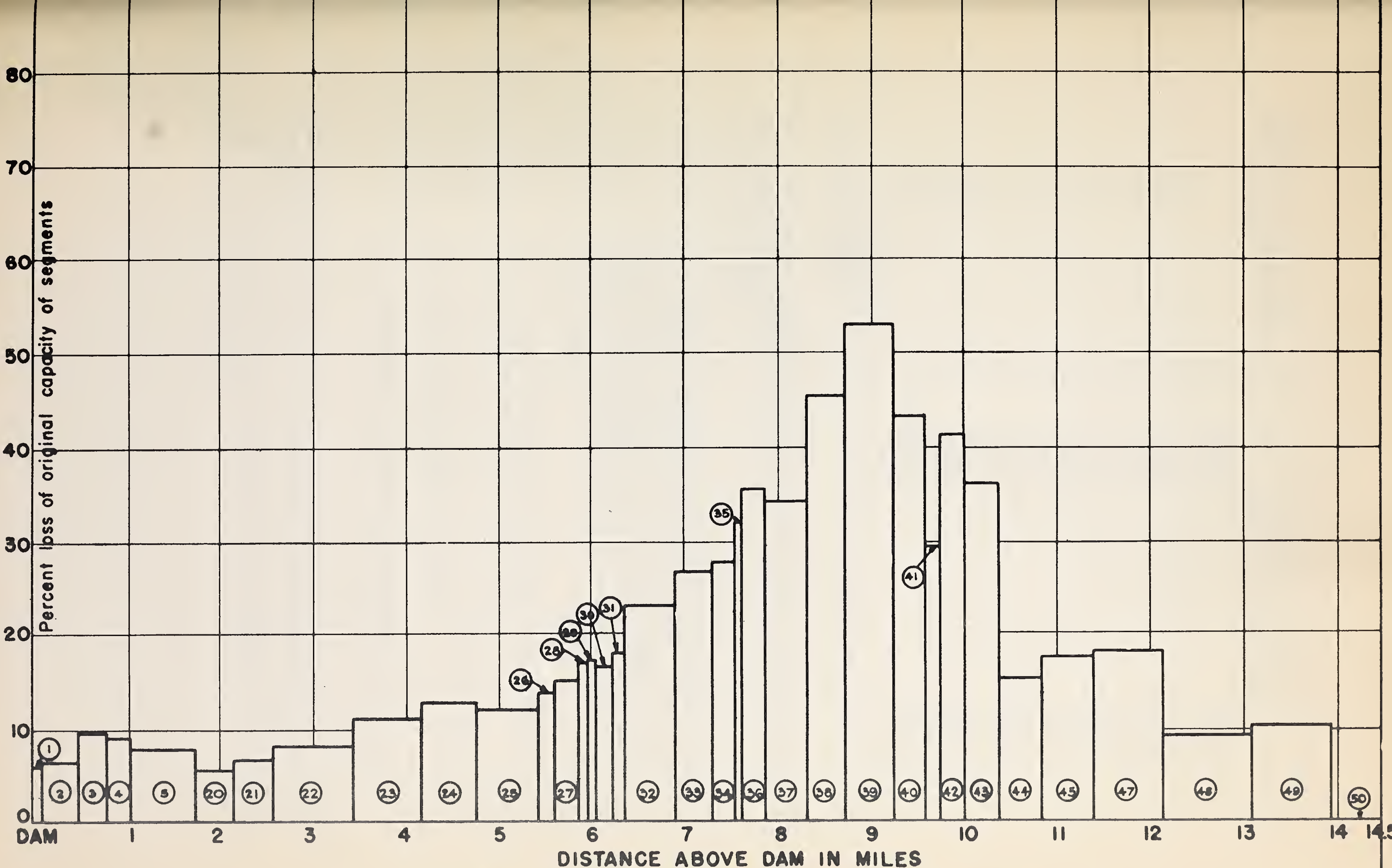
Relatively small areas of above-crest deposits have accumulated at the heads of the Sand Creek and Big Creek arms.

In the ponded channel above the open lake little or no silt occurs on the channel bottom in most straight reaches but thicknesses of 2 to 8 feet were measured on the inside of some bends.

On submerged valley walls and other areas above the general level of the valley flat little or no silt has accumulated. This fact suggests two points concerning the manner of deposition: (1) that subsiding sediment tends to be deflected toward deeper areas, and (2) that sediment accumulating on eminences of the lake bottom tends to migrate down the adjacent slopes after deposition.

The extent to which the capacity of each segment has been reduced by sedimentation is brought out diagrammatically in figure 4. The width of each block in the diagram represents the approximate average length of the segment, and the height indicates percentage loss of original capacity. Segment 39, in which the maximum proportional reduction of capacity has occurred, includes the lower end of the delta area described above.

Suspended sediment.- Sampling of suspended solids in the reservoir water was undertaken cooperatively by representatives of the Illinois Water Survey Division and the field party making this survey. Two series of water samples, collected through the length of the reservoir on May 4 and 6, respectively, following heavy rains, were analyzed by the Illinois Water Survey Division with the following results:



CAPACITY LOSS BY SEGMENTS IN LAKE DECATUR

FIGURE 4.

L-1830

Table 6.- Suspended solids in water samples from Lake Decatur.

Distance above dam (Miles)	Suspended solids (Parts per million) May 4	May 6
0.1	52.9	21.6
1.1	37.0	28.6
2.1	36.9	34.8
2.9	33.8	69.3
4.1	60.4	196.2
5.3	77.8	392.2
5.7	86.8	398.2
6.2	81.2	(518.0
7.2	102.9	1/(410.0
7.7	117.4	415.5
8.2	220.7	403.0
8.8	343.8	364.2
9.6	(534.5	318.2
11.2	1/(504.5	344.0
2.4 (Big Creek arm)	51.3	31.5

1/ Peak load.

Dr. Max Suter, engineer of the Illinois Water Survey Division, who made the analyses, arrived at the following significant conclusions: (8)

> 1.- With an average inflow of 2,280 cubic feet per second, which is a normal flood flow, the lake can be filled in less than 5 days. This figure corroborates the rate of movement of 4 miles in 48 hours as shown by turbidity measurements.
>
> 2.- No zone of heavy silt deposition exists in the upper portion of the lake.
>
> 3.- Flood waters bring large quantities of colloidal matter into the lake.
>
> 4.- Sedimentation can be expected to be fairly uniform through the length of the lake.

The above conclusions are in harmony with the results of silt measurements during the 1936 survey. Suter's brief report is especially significant in indicating the value of data which can be obtained by a more extensive investigation of suspended material in reservoirs.

Wave erosion.- An examination of the shore zones of Lake Decatur revealed that wave erosion and associated current action are factors of significance in the processes of destructive sedimentation in the reservoir, and suggested the need for quantitative measurements of the results of these processes (fig. 3B).

Ordinarily a simple method of making these measurements would be to plot present and original profiles on established ranges and from these determine the volume of material removed from above crest. Unfortunately, in this case, measured profiles of the original shore are not available, and the common occurrence of over-steepened or vertical bluffs along the original shore make reconstruction by projection of the unaltered parts of profiles extremely difficult and of doubtful reliability. The higher precipitous bluffs, chiefly of glacial till, in all probability have not changed appreciably in slope since they were first exposed to wave action. They were originally steep valley-wall bluffs carved by lateral planation of the Sangamon River. Since the lake first impinged upon the foot of the bluffs wave erosion has cut them back without materially changing the slope. Therefore, a downward projection of the slope above the bluff would not give a true reconstruction of the original condition. For this reason accurate quantitative measurements of wave erosion must in many cases await future surveys, when new profiles may be compared with profiles recorded in 1936. In a few cases detailed field studies indicated that projected original profiles could be drawn with some assurance of accuracy, but as these would not yield quantitative data for the lake as a whole computations were not made as a part of this survey.

In order, however, to establish a basis for future quantitative measurements of the results of wave erosion, 27 detailed shore-line profiles were established and permanently marked as described under History of Survey. The following localities for such measurements were selected to represent as nearly as possible all of the shore-line types in the lake.

Wave erosion ranges on Lake Decatur.

Location	Remarks
Main Lake:	
North-west shore:	
Range end 022 (1 mi. above dam) -----	Very steep high bluff, slightly modified. Riprap.
039 ---------	Moderate bluff, slightly modified.
053 ---------	Steep originally, much modified.
057 ---------	High precipitous bluff, little modified.
South-east shore:	
020 (0.5 mi. above dam) -----	Very steep high bluff, slightly modified. Riprap.
08 ---------	Very steep high bluff, slightly modified. Riprap.
05 ---------	High precipitous bluff, somewhat modified. Riprap.
099 ---------	High precipitous bluff, originally steep.
097, 098 ----	High precipitous bluff, originally steep.
0107 ---------	Probably entirely wave-cut.
0108, 0109 ---	Originally steep bluff, much modified.
045 ---------	Moderate bluff, slightly modified.
054 ---------	Originally steep, much modified.
Sand Creek arm:	
East shore:	
012 (at mouth)	Originally steep, much modified.
0105, 0106 ---	Originally steep, somewhat modified.
095 ---------	Originally steep, modified.
093 ---------	Originally steep, modified.
Big Creek arm:	
North shore:	
0100, 0101A, 0101B (0.5 mi. above mouth) --	Low bank resulting entirely from wave erosion.
0104, 0103, 0102 --	Nearly vertical high bank originally modified.
026 -----------	Originally steep bluff, somewhat modified. Riprap.
027 ----------	High precipitous bluff, somewhat modified.

Relatively coarse material comprises the bulk of the sediment on the wave-built beaches and extending 20 to 100 feet from shore on the lake bottom. As the parent material in the

valley walls is heterogeneous both texturally and mineralogically, wave action disintegrates it into a variety of sediment types. Any dissolved material and much of the clay and colloidal matter are carried from the point of origin through the lake and over the spillway. Some clay, much silt, and some of the finest sand are carried out into the lake by slow currents and become a part of the bottom sediment. The coarser sand, grit, and gravel form the beaches and near-shore gravel zones. A study of these relationships has suggested that mechanical analyses of the till along the shore at a given locality, together with a determination of the amount of coarse material in the adjoining gravel zone, might furnish a reliable measure of the amount of shore-line erosion.

Riprapping was resorted to several years ago as a means of protecting property along the lower lake shore from damage by wave erosion. Up to the present time more than two-thirds of the shore has been protected by a riprap of large angular rocks at a cost of more than $97,000, according to city officials. This program appears to have effectively stopped further wave cutting in reaches of the shore that have been treated.

Origin of sediment:

The major sources of bottom sediment are the surficial loess and loess-derived soils of the watershed. Silt and clay-size particles from glacial till constitute a minor contribution of unknown proportions.

Wave action is a factor of some importance in supplementing the deposits laid down by contributing streams. The steep shores of unconsolidated drift formations are not very resistant to wave erosion. Sand and gravel beaches have formed along many miles of shore line as waves and currents have attacked the banks.

Summary:

Lake Decatur may be regarded as typical of large shallow reservoirs in the Midwestern Corn Belt, a glaciated region of low relief. Comparable rates of reservoir sedimentation and watershed erosion may be expected for similar reservoirs with large watersheds in farm regions on the younger glacial formations.

Recommendations:

(1) On the basis of available information on the watershed it appears that the most dangerous erosion from the standpoint of reservoir silting occurs in belts of relatively

steep land up to 1 mile wide bordering the Sangamon River valley and extending up a few of the principal tributaries. For the purpose of protecting Lake Decatur, rigorous erosion-control measures on this strip of land might prove, after careful study, to be of sufficient urgency to warrant contribution on the part of the city to its early prosecution.

(2) The loose block riprap now in place around most of the lower lake is apparently proving effective in prevention of shore erosion. Its extension to all areas of the lake subject to wave erosion is advocated, particularly to the steep exposed shore lines along the eastern shores.

(3) Planting of suitable erosion-preventing vegetation above the riprap zone on steep shore-line banks is advocated to stabilize these banks against further gullying, slumping and sheet wash.

The following tabulation is a statistical summary of data relating to Lake Decatur, Decatur, Ill.

	Quantity	Unit
Age:[1/]	14.2	Years
Watershed:		
Total area	906	Square miles
Reservoir:		
Original area at crest stage	2,805	Acres
Present area at crest stage	2,747	Acres
Original storage capacity	19,738	Acre-feet
Present storage capacity	16,930	Acre-feet
Original storage per square mile of drainage area	21.79	Acre-feet
Present storage per square mile of drainage area	18.69	Acre-feet
Original storage per acre of drainage area	0.41	Acre-inches
Present storage per acre of drainage area	0.35	Acre-inches
Sedimentation:		
Delta deposits	Not measured separately	
Bottom-set beds		
Total sediment	2,808	Acre-feet
Accumulation per year average	198	Acre-feet
Accumulation per year per 100 square miles of drainage area	21.9	Acre-feet
Accumulation per year per acre of drainage area	14.87	Cubic feet
Or, assuming average weight of 1 cubic foot of silt is 100 pounds	0.74	Tons
Depletion of storage:		
Loss of original capacity per year	1.00	Percent
Loss of original capacity to date of survey	14.23	Percent

1/ Date storage began: April 16, 1922.
Date of this survey: April 8, 1936 to July 3, 1936.

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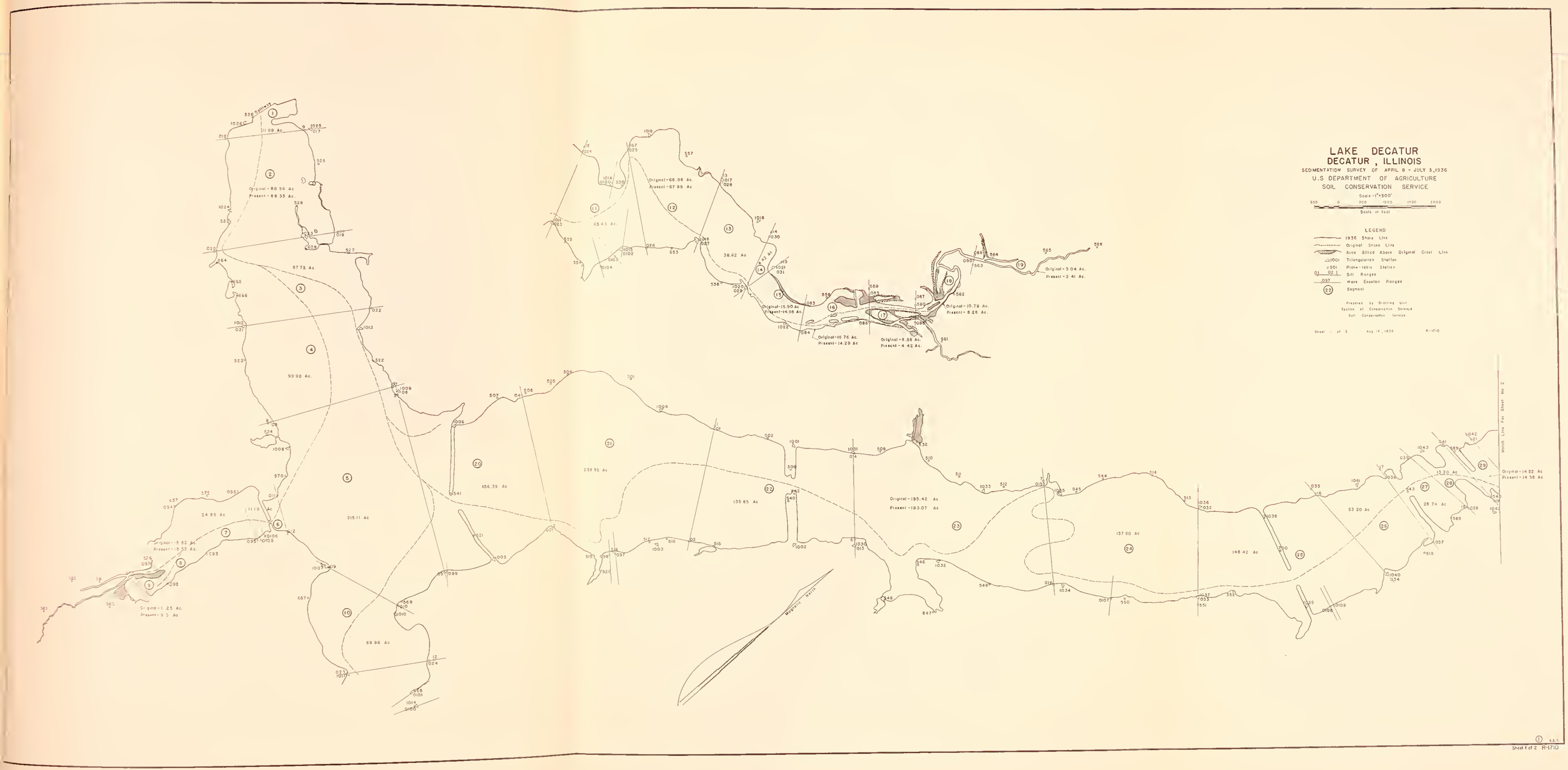
Figure 2-A



LAKE DECATUR
DECATUR, ILLINOIS
SEDIMENTATION SURVEY OF APRIL 8 - JULY 3, 1936
U.S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Scale - 1" = 500'
500 0 500 1000 1500 2000
Scale in feet
LEGEND
1936 Shore Line
Original Shore Line
Area Silted Above Original Crest Line
1001 Triangulation Station
501 Plane-table Station
Sill Ranges
097 Wave Erosion Ranges
22 Segment
Prepared by Drafting Unit
Section of Conservation Surveys
Soil Conservation Service
Spillway
Magnetic North
Match Line For Sheet No. 2
Sheet 1 of 2 R-1710

Figure 2-B


LAKE DECATUR
DECATUR , ILLINOIS
SEDIMENTATION SURVEY OF APRIL 8 - JULY 3, 1936
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Scale - 1" = 500'
500 0 500 1000 1500 2000
Scale in feet
LEGEND
1936 Shore Line
Original Shore Line
Segment
Original - 114 96 Ac
Present - 111 00 Ac
Original - 63 48 Ac
Present - 68 31 Ac.
Original - 41 80 Ac
Present - 29 60 Ac.
Original - 12 81 Ac
Present - 8 62 Ac
Original - 19 28 Ac
Present - 14 17 Ac
Original - 35 35 Ac
Present - 32 88 Ac
Original - 7.86 Ac
Present - 7 83 Ac
Original - 8 44 Ac
Present - 8.35 Ac
Original - 11.88 Ac
Present - 11 71 Ac
Original - 11 48 Ac
Present - 11 37 Ac
Original - 52 11 Ac
Present - 49.64 Ac
121 04 Ac.
61 73 Ac
35.78 Ac
14 32 Ac
37 94 Ac
Magnetic North
Match Line For Sheet No. 1
Sheet 2 of 2 R-1710